Diversity and Abundance of ants along an elevational gradient in Jammu-Kashmir Himalaya - I

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Abstract

Ant diversity was studied at an altitude of 1000mtrs and 2000mtrs above mean sea level along an elevational gradient in Jammu-Kashmir Himalaya. Ants were collected with the help of pitfall traps, winkler's and hand collection along a transect of 250mtrs at each site. Species richness was estimated with the help of Colwell's EstimatorS. Subfamily Myrmicinae has been found to be 66%, followed by Formicinae 26.81%, Ponerinae 4.84% and Dolichoderinae 2.35%. The data generated reflects that with decrease in temperature and humidity, composition of species changes as in case of Myrmicinae, the generalist species are replaced by more high altitude specialists like *Myrmica* and *Aphaenogaster.* In case of Formicinae, the interpretation resembles Myrmicinae as cold specialist *Formica* increases in abundance. But interestingly, the overall abundance increases from 1000mtrs to 2000mtrs with number of species almost same at both the elevations.

Keywords: *Ants, diversity, species richness, species abundance, elevational gradient, estimation indices, Jammu-Kashmir Himalaya.*

Introduction

Since the origin of Biogeography, many important studies have been carried on diversity of Insects along elevational gradients. But among insects, ants have been used more frequently by various workers in recent times.

Himalaya is listed as one of the biodiversity hotspots, harbours a number of endemic species since its origin in Paleogene period about 70 million years ago (Bharti, 2008). Within the Himalayan range, the area of Jammu-Kashmir is biogeographically most complex and diverse.

Since the recognition of elevational gradients by Linnaeus, these continued to serve as a heuristic tool and natural experimental site for generations of scientists; Van Humboldt (1849), Darwin (1839, 1859), Wallace (1876, 1878) and Whittaker (1960) to mention a few. Wheeler (1917), Weber (1943) and Gregg (1963) observed ants at high elevations above 2000 meters in mountains of North America, Sudan and Colorado respectively. According to Hutchinson (1959), Preston (1962a and 1962 b), Connell and Orians (1964), MacArthur (1965, 1969 and1972), Brown and Lomolino (1998) and Sanders (2002) there are two general predictions of how species richness and elevation are related; either species richness decreases monotonically with increasing elevation or richness peaks at mid elevations due to

increase in productivity. Rahbek (1995), while studying the elevational gradients of species richness emphasized on the importance to discriminate between patterns reflecting recent diversification and those reflecting long term accumulation of species.

During extensive studies on elevational gradients in Madagascar, Fisher (1996a and 1996b, 1997, 1998, 1999, 2002 and 2004) concluded that species richness is peaked at mid-elevation and emphasized that it could be the result of the mixing of two distinct, lower and montane forest ant assemblages. Samson *et al.* (1997) surveyed ant communities along an elevational gradient in the Philippines extending from lowland dipterocarp forest (250m) elevation to mossy forest (1750m) and found that very few ants occur at high elevations in the tropics. From Sabah, Borneo, Bruhl *et al.* (1998) studied stratification of ants in a primary rain forest. They observed dominance of Myrmicinae (39.9%) followed by Formicinae (31.5%), Ponerinae (11.5%) and Dolichoderinae (10.2%). Later, Bruhl *et al.* (1999) monitored altitudinal distribution of leaf litter ants along a transect in primary rain forest on Mount Kinabalu. The number of ant species decreased exponentially without evidence of a peak in species richness at mid-elevation.

Gunsalam (1999),Yamane and Hashimoto (1999), Noon-anant (2003) and Watanasit (2003), found that a combination of various ant sampling methods yield better results in the evaluation of ant species. The role of scale and species richness in defining the hierarchical theory of species diversity was discussed by Whittaker *et al.* (2001). Lomolino (2001), Sanders *et al.* (2003) discussed the patterns of ant species richness along elevational gradients in an arid ecosystem and role of area, geometry and Rapoport's rule in species richness. While, Xu *et al.* (2001) observed ant communities and their species diversity with altitudinal zonation on west and east slope of Gaoligongshan Mountain in China. Watt *et al.* (2002) worked on the effect of diversity and abundance of ants in relation to forest disturbances in Cameroon and supported the view that deforestation can reduce arthropod species richness.

Araujo and Fernandes (2003) monitered the distribution of ants along altitudinal gradients from 800m to 1500m, while Robinson *et al.* (2003) studied wood ant (*Formica lugubris*) population in Upper Dearne Woodlands, to investigate relationship between ant activity and factors such as light level, slope and vegetation. Schonberg *et al.* (2004) analysed arboreal ant species richness in primary forest, secondary forest and pasture habitat of a tropical Montane Landscape.

More recently, Gunawardene *et al.* (2008), Kumar and Mishra (2008), Malsch *et al.* (2008) and Sabu *et al.* (2008) monitored ant species richness along elevational gradient, in lowland forests and in agroecosystems. In one of the significant contributions, Nogues-Bravo *et al.* (2008) assessed scale effects and human impact on the elevational species richness gradients. From Himalaya, Bharti (2008) analysed altitudinal diversity of ants and found that about 45% of Himalayan ant fauna is endemic to this region. The present study is the first contribution dealing with diversity and abundance of ants from Himalaya.

Materials and Methods

The sampling sites for the study were spaced by an altitude of 1000 meters, since a shift in an altitude of 1000 meters in Himalayan region has pronounced effect on temperature, precipitation, humidity, decomposition, vegetation etc. (Mani, 1962). For this study, the sampling was carried using standard protocols

for ant collection along an elevational gradient following Fisher (2004). At each elevation, 50 pitfall traps and 50 leaf litter samples (winkler's) were used in parallel lines, 10 meters apart along 250 meter transect. The site for each transect was chosen in the interior of forest with the intent of sampling representative microhabitats found at each elevation.

Leaf litter samples were sifted in a 1 m × 1 m quadrant, every 5 meter along the transect using a litter sifter (Bestelmeyer *et al.*, 2000) through a wire sieve with square holes of 1 cm × 1 cm. Ants and other invertebrates were extracted from the sifted litter during a 48-hour period in mini-winkler sacks (Fisher, 1999, 2004). The litter samples were shaken with the help of machete to agitate the invertebrates, hence increasing the potential for further collection from the litter.

The pitfall traps consisted of test tubes with an 18mm internal diameter and 150mm long, partly filled to a depth of about 50 mm with soapy water and 5% ethylene glycol solution, inserted into PVC sleeves and buried with the rim flush with the soil surface, provided with a lid to prevent rainfall from flooding the traps. Material was collected after 48 hours and stored in 70% ethanol. In addition to above mentioned methods, ants were also collected by hand picking method. Ants were then separated from other invertebrates, pin-mounted and identified to species level.

Data analysis

Data was analysed by Incidence-based coverage estimator (ICE), species observed (Mao Tau) Chao 1, Chao 2 and bootstrap mean. Species richness and Alpha diversity was estimated by using Shannon wiener, and Simpson's D diversity indices. The program EstimateS (Colwell, 2006) was used to calculate these standard estimators.

Results and Discussion

A total of 1,446 ants belonging to 19 species were collected. Ponerinae and Dolichoderinae are represented by single genera each, while Myrmicinae and Formicinae by 5 genera each. More than half of the species belong to subfamily Myrmicinae (66%), followed by Formicinae (26.81%), Ponerinae (4.84%) and Dolichoderinae (2.35%). Hand collection yielded maximum number of specimens (45.27%) followed by Winkler's (28.81%) and Pitfall Trap (25.92%).

At 1000mtrs (Table -1, Graph-1, Pi chart-I & III) subfamily Myrmicinae was found to be maximum (49.96%). Genus *Crematogaster* represents 47.56% of the total catch and majority of the specimens were collected by hand picking method followed by winkler's and pitfall. Subfamily Formicinae represents 34.40% with genus *Camponotus* forming the bulk with 37.56%, again hand picking method was found to be most effective followed by winkler's and pitfall. Subfamily Dolichoderinae and Ponerinae are represented by single genus. But in case of Ponerinae maximum catch was found to be in winkler's collection and in terms of number of specimens, Ponerinae out numbered Dolichoderinae. This fact could be attributed to the humidity present in leaf litter.

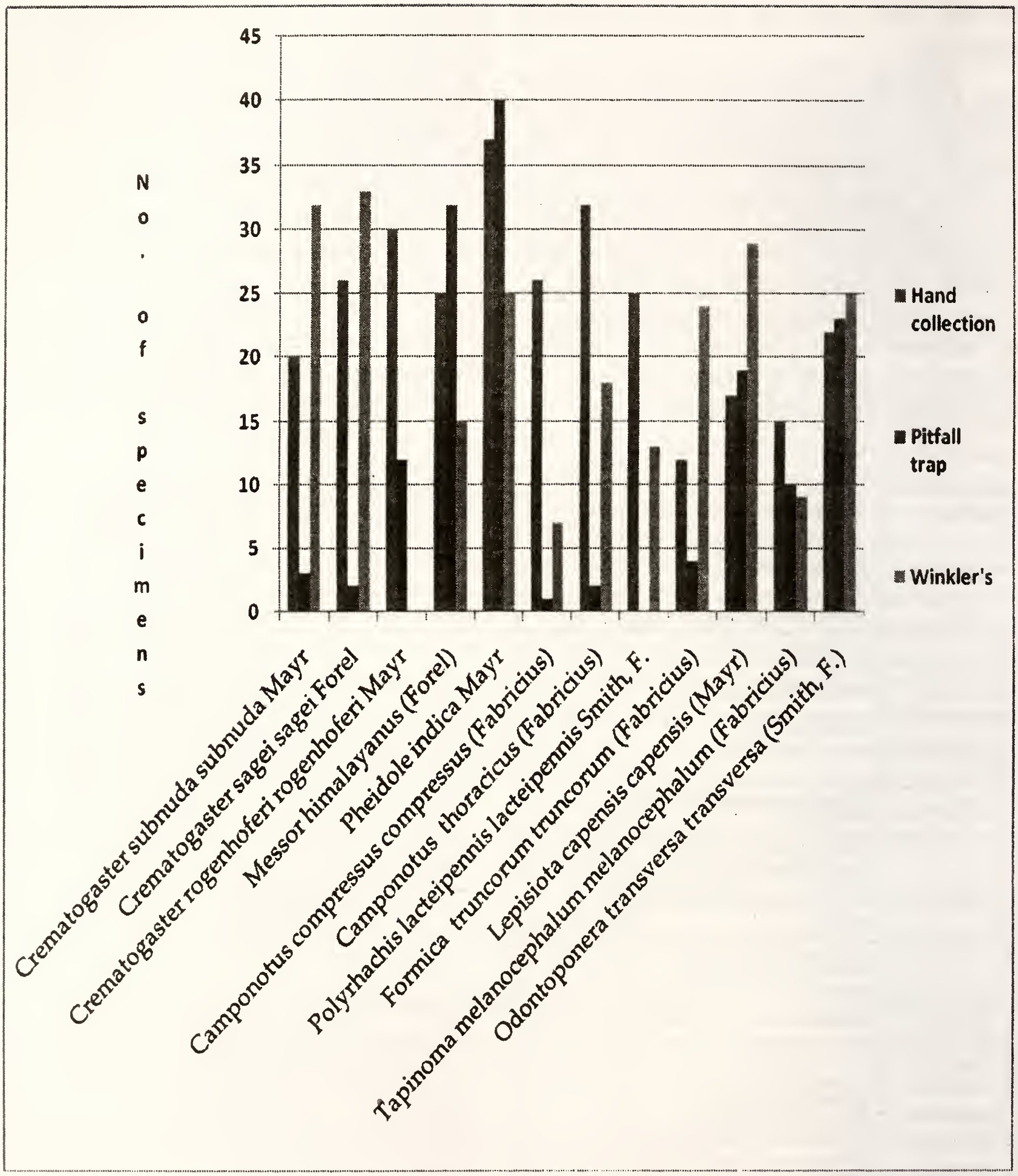
At 2000mtrs (Table-2, Graph-2, Pi chart-II & IV) subfamily Myrmicinae represents 79.64%, genus *Myrmica* as the dominant one with 88.10%. Subfamily Formicinae (20.36%) is mainly represented by *Formica* (72.32%). Two species of *Camponotus,* one each of *Formica* and *Lepisiota* have been found at both the altitudes. At 1000 mtrs, the average temperature was 22°C and relative humidity 52%. The total catch in terms of number of specimens was 665 (Table-1), while with temperature 13.7°C and relative humidity 45%,

the total catch has been found to be 781 at 2000 mtrs.

Species richness by different indices have been depicted in table-5 and species abundance and effectiveness of sampling methods by Sobs (species observed) Mao Tau (Graph-5) while Alpha diversity indices have been depicted in Table-6. The data generated reflects that with decrease in temperature and humidity, composition of species changes ;as in case of Myrmicinae the generalist species are replaced by more high altitude specialists like *Myrmica* and *Aphaenogaster*. In case of Formicinae the interpretation resembles Myrmicinae as cold specialist *Formica* increases in abundance. But interestingly, the overall abundance increases from 1000mtrs to 2000mtrs with number of species almost same at both the elevations. At this point of time, it is difficult to conclude that with more increase in altitude, the number of species and abundance would increase, but Bharti (2008) has observed that with increase in altitude in Himalaya, genera like *Myrmica, Lasius, Aphaenogaster* and *Temnothorax* gradually dominate the ant fauna and are represented by maximum number of endemic species, with Myrmicinae most speciose subfamily followed by Formicinae.

Table-1: (Showing data at 1000 mtrs)

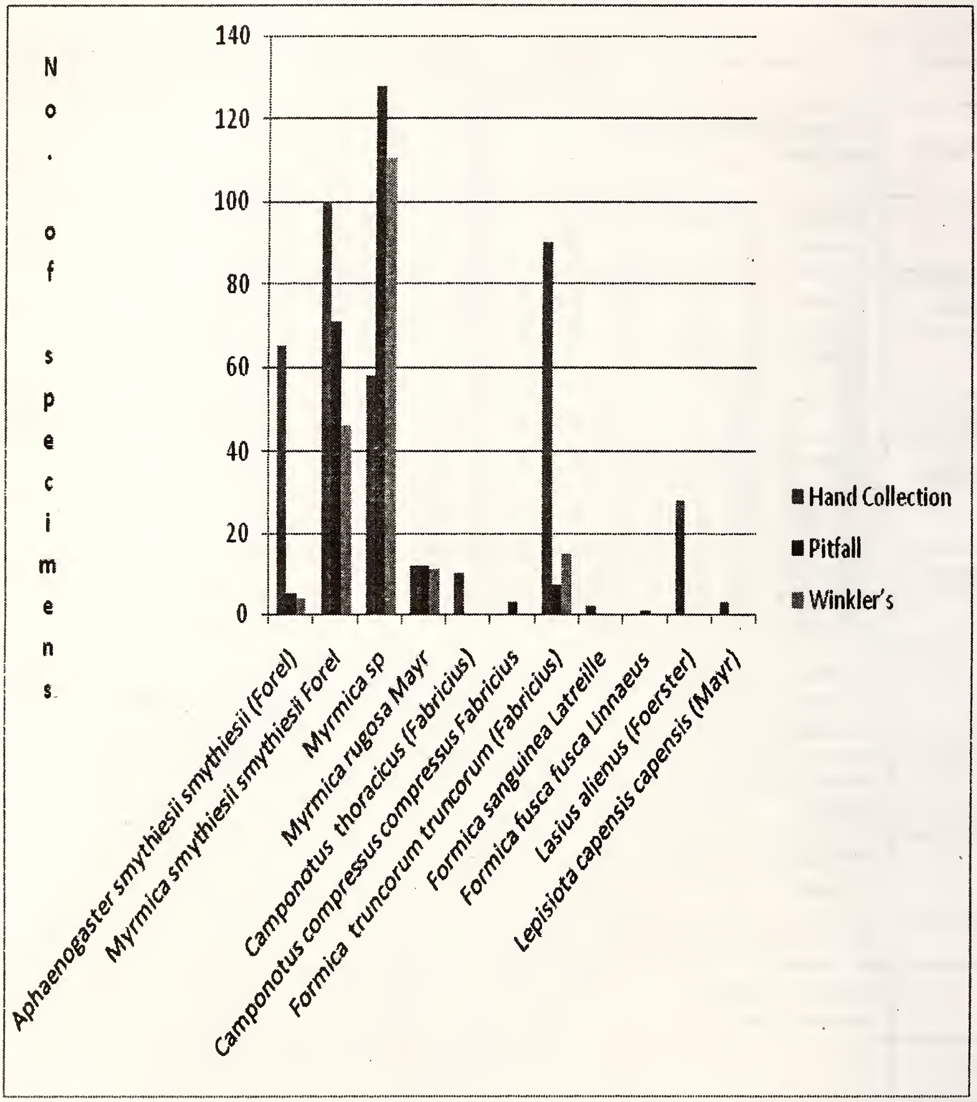
Subfamily	Species	Hand collection	Pitfall trap	Winkler's	Total	Total %age	%age within subfamily
Myrmicinae	*Crematogaster subnuda subnuda* Mayr	20	3	32	55	8.27%	16.75%
	Crematogaster sagei sagei Forel	26	2	33	61	9.17%	18.37%
	Crematogaster rogenhoferi rogenhoferi Mayr	30	12		42	6.36%	12.65%
	Messor himalayanus (Forel)	25	32	15	72	10.82%	21.69%
	Pheidole indica Mayr	37	40	25	102	15.34%	30.72%
Total		**138**	**89**	**105**	**332**	**49.96%**	**100.00%**
Formicinae	*Camponotus compressus compressus* (Fabricius)	26	1	7	34	5.11%	14.85%
	Camponotus thoracicus (Fabricius) [*Camponotus dichrous* Andre]	32	2	18	52	7.82%	22.71%
	Polyrhachis lacteipennis lacteipennis Smith, F.	25		13	38	5.71%	16.59%
	Formica truncorum truncorum (Fabricius) [*Formica truncicola* Nylander]	12	4	24	40	6.06%	17.47%
	Lepisiota capensis capensis (Mayr)	17	19	29	65	9.70%	28.38%
Total		112	26	91	229	34.40%	100%
Dolichoderinae	*Tapinoma melanocephalum melanocephalum (Fabricius)*	15	10	9	34	5.11%	
Ponerinae	*Odontoponera transversa transversa* (Smith, F.)	22	23	25	70	10.53%	
Grand Total		287	148	230	665	100%	



Graph-1: (Showing the no. of specimens per species at 1000mtrs)

Table-2: (Showing data at 2000 mtrs)

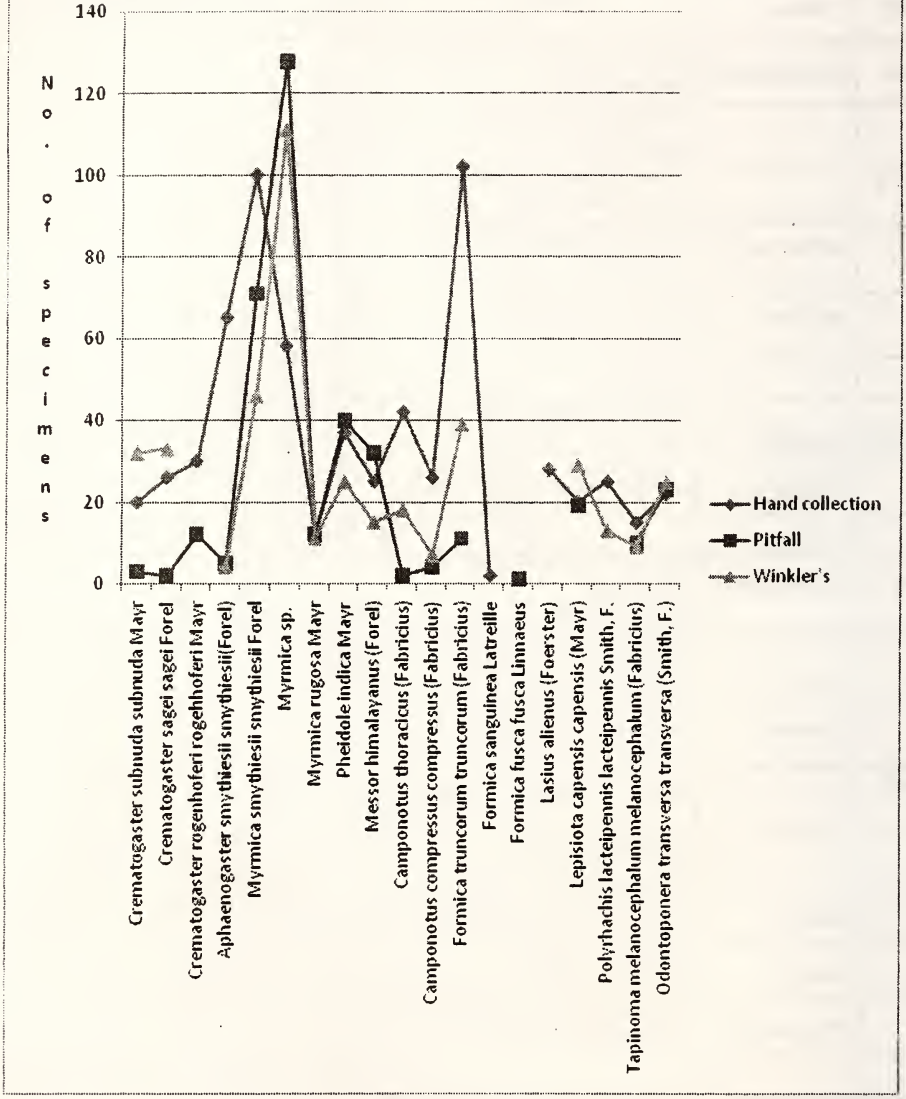
Subfamily	Species	Hand collection	Pitfall trap	Winkler's	Total	Total %age	%age within subfamily
Myrmicinae	*Aphaenogaster smythiesii smythiesii* (Forel)	65	5	4	74	9.48%	11.90%
	Myrmica smythiesii smythiesii Forel	100	71	46	217	27.78%	34.89%
	Myrmica sp.	57	128	111	296	37.90%	47.58%
	Myrmica rugosa Mayr	12	12	11	35	4.48%	5.63%
Total		**234**	**216**	**172**	**622**	**79.64%**	**100.00%**
Formicinae	*Camponotus thoracicus* (Fabricius) [*Camponotus dichrous* Andre]	10			10	1.28%	6.29%
	Camponotus compressus compressus Fabricius		3		3	0.38%	1.89%
	Formica truncorum truncorum (Fabricius) [*Formica truncicola* Nylander]	90	7	15	112	14.39%	70.43%
	Formica sanguinea Latreille	2			2	0.26%	1.26%
	Formica fusca fusca Linnaeus		1		1	0.13%	0.63%
	Lasius alienus (Foerster)	28			28	3.54%	17.61%
	Lepisiota capensis capensis (Mayr)	3			3	0.38%	1.89%
Total		133	11	15	159	20.36%	100%
Grand Total		367	227	187	781	100%	



Graph-2: (Showing the no. of specimens per species collected from 2000mtrs)

Table-3: (Showing combined data at both elevations)

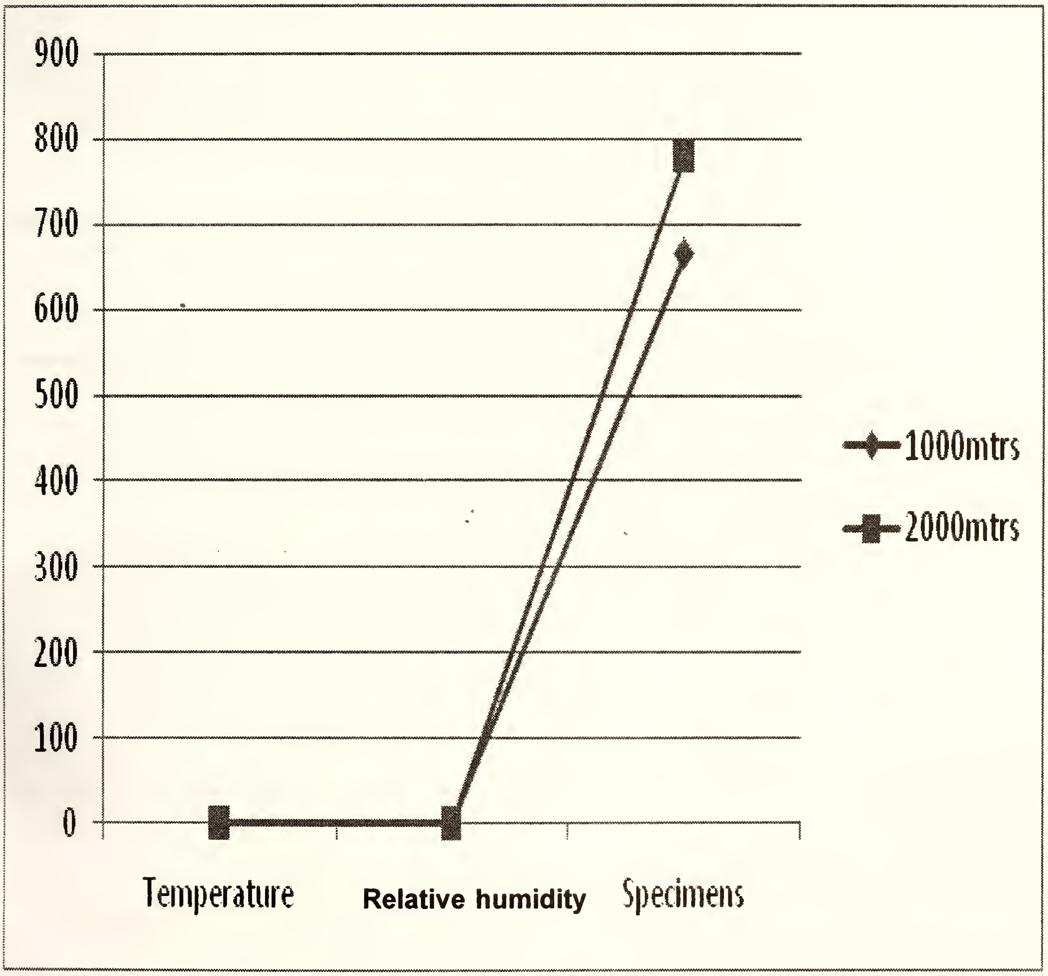
Subfamily	Genus	Species	Hand collection	Pitfall trap	Winkler's	Total	Total %age
Myrmicinae	*Crematogaster*	*Crematogaster subnuda subnuda* Mayr	20	3	32	55	3.80%
		Crematogaster sagei sagei Forel	26	2	33	61	4.22%
(5 Genera, 9 species)		*Crematogaster rogenhoferi rogenhoferi* Mayr	30	12		42	2.90%
	Aphaenogaster	*Aphaenogaster smythiesii smythiesii* (Forel)	65	5	4	74	5.11%
	Myrmica	*Myrmica smythiesii smythiesii* Forel	100	71	46	217	15.00%
		Myrmica sp.	57	128	111	296	20.52%
		Myrmica rugosa Mayr	12	12	11	35	2.42%
	Pheidole	*Pheidole indica* Mayr	37	40	25	102	7.05%
	Messor	*Messor himalayanus* (Forel)	25	32	15	72	4.98%
Total			**372**	**305**	**277**	**954**	**66.00%**
Formicinae	*Camponotus*	*Camponotus thoracicus* (Fabricius) [*Camponotus dichrous* Andre]	42	2	18	62	4.28%
		Camponotus compressus compressus (Fabricius)	26	4	7	37	2.56%
	Formica	*Formica truncorum truncorum* (Fabricius) [*Formica truncicola* Nylander]	102	11	39	152	10.50%
(5 Genera,8 species)		*Formica sanguinea* Latreille	2			2	0.14%
		Formica fusca fusca Linnaeus		1		1	0.07%
	Lasius	*Lasius alienus* (Foerster)	28			28	1.94%
	Lepisiota	*Lepisiota capensis capensis* (Mayr)	20	19	29	68	4.70%
	Polyrhachis	*Polyrhachis lacteipennis lacteipennis* Smith, F.	25		13	38	2.63%
Total			**245**	**373**	**106**	**388**	**26.81%**
Dolichoderinae	*Tapinoma*	*Tapinoma melanocephalum melanocephalum* (Fabricius)	15	10	9	34	2.35%
Ponerinae	*Odontoponera*	*Odontoponera transversa transversa* (Smith, F.)	22	23	25	70	4.84%
Grand Total			**654**	**375**	**417**	**1446**	**100%**



Graph-3: (Showing Abundance and effectiveness of collection methods at both the elevationas combined)

Table-4: (Showing relative humidity and average temperature at both elevations)

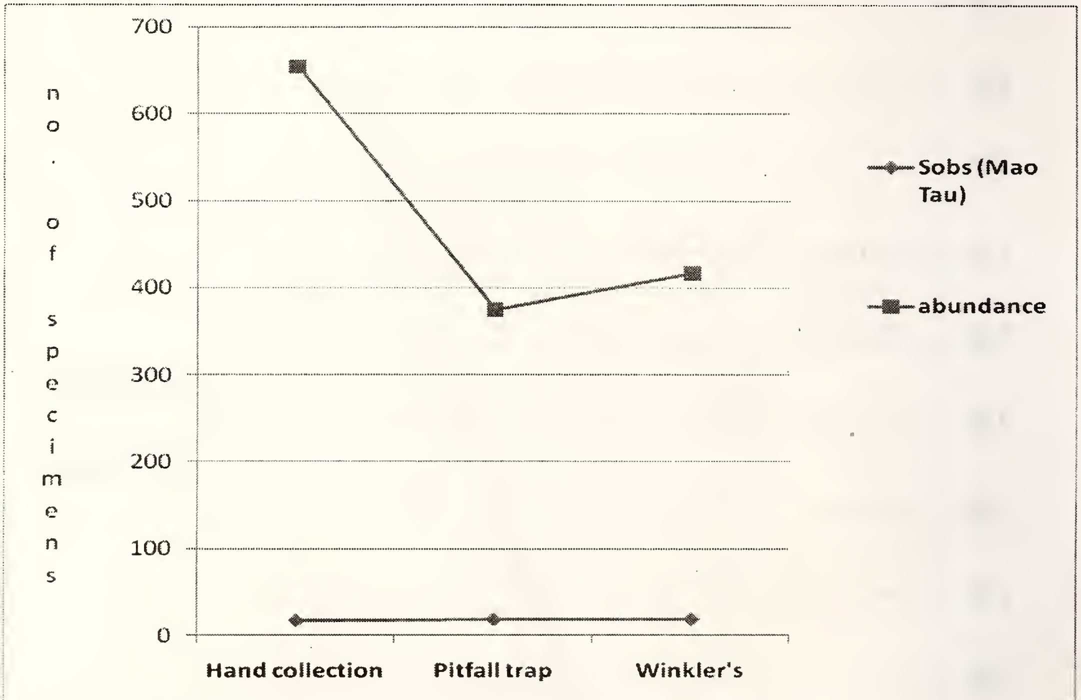
Altitude	1000 mtrs	2000 mtrs
Temperature	22°C	13.7°C
Relative Humidity	52%	45%
Specimens	665	781



Graph-4: (Showing correlation of temperature and humidity with species abundance)

Table-5: (Showing the species richness by different indices)

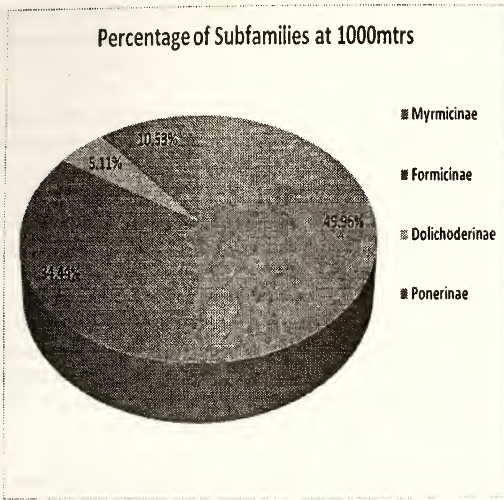
Samples	Individuals (computed)	Sobs (Mao Tau)	Sobs Mean (runs)	ACE Mean	ICE Mean	Chao 1 Mean	Chao 2 Mean	Jack 1 Mean	Jack 2 Mean	Bootstrap Mean
Hand collection	406.67	17.67	19	19.6	133	19	133	19	0	19
Pitfall trap	813.33	19	19	19	19.56	19	19	19.5	19.5	19.25
Winkler's	1220	19	19	19	19	19	19	19	18.33	19.15



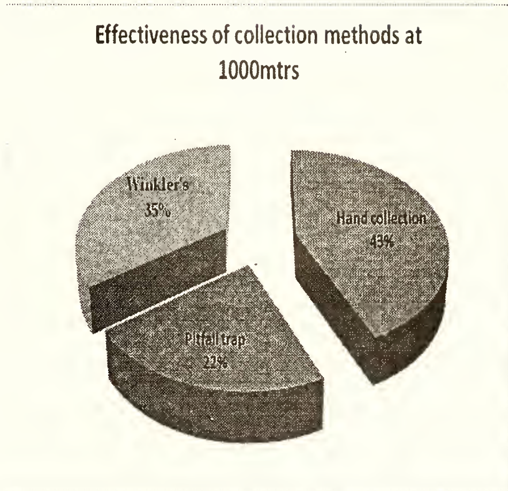
Graph -5: (Showing the species abundance and effectiveness of sampling method by Sobs (Mao Tao))

Table-6: (Showing Alpha diversity indices)

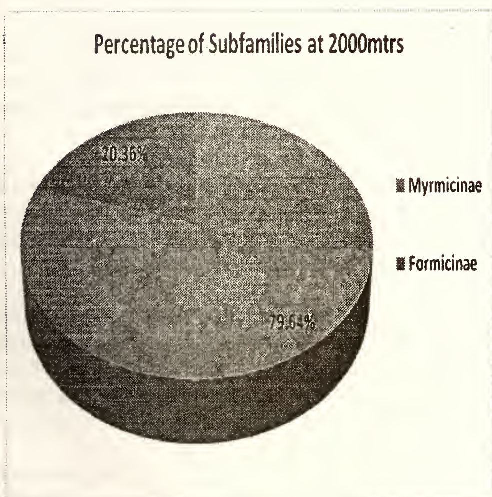
Samples	Winkler's	Alpha SD (analytical)	Shannon Mean	Simpson Mean
Hand collection	5.26	0.7	2.77	15.75
Pitfall trap	3.45	0.34	2.79	14.25
Winkler's	3.19	0.3	2.71	12.25



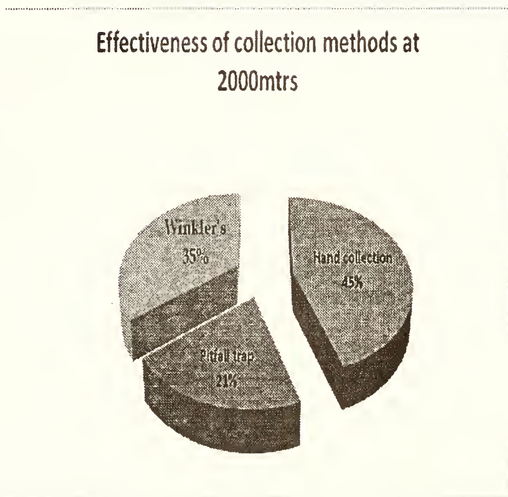
Pi chart-I



Pi chart-III



Pi chart-II



Pi chart-IV

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